VYSOKÉ UČENÍ TECHNICKÉ V BRNĚ
BRNO UNIVERSITY OF TECHNOLOGY

FAKULTA ELEKTROTECHNIKY A KOMUNIKAČNÍCH TECHNOLOGIÍ
FACULTY OF ELECTRICAL ENGINEERING AND COMMUNICATION

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DEPARTMENT OF FOREIGN LANGUAGES

KOMENTOVANÝ PŘEKLAD

COMMENTED TRANSLATION

BAKALÁŘSKÁ PRÁCE
BACHELOR'S THESIS

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BRNO 2016

VYSOKÉ UČENÍ TECHNICKÉ V BRNĚ
FAKULTA ELEKTROTECHNIKY A KOMUNIKAČNÍCH TECHNOLOGIÍ

Bakalářská práce

bakalářský studijní obor **Angličtina v elektrotechnice a informatice**
Ústav jazyků

ID: 146021
Akademický rok: 2015/16

Komentovaný překlad

POKYNY PRO VYPRACOVÁNÍ:

Překlad odborného nebo populárně naučného textu.
Analýza jazykových prostředků v obou jazycích a jejich srovnání.

DOPORUČENÁ LITERATURA:

Krhutová: Parameters of Professional Discourse, Tribun EU, Brno 2009

Widdowson: Linguistics, OUP, Oxford 2008

Knittlová, D.: Překlad a překládání, UP, Olomouc, 2010

Termín zadání: 11.2.2016 ***Termín odevzdání:*** 27.5.2016

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doc. PhDr. Milena Krhutová, Ph.D., *předseda oborové rady*

Anotace

Tato bakalářská práce má za úkol přeložit odborný text z oblasti jaderných elektráren a následně analyzovat jazykové prostředky použité v textu. Práce je rozdělena do dvou hlavních částí – praktická část a teoretická část. Praktická část představuje samotný překlad odborného textu. Teoretická část se zabývá hlavní charakteristikou odborného stylu a analýzou jazykových (konkrétně lexikálních a syntaktických) prostředků.

Klíčová slova

komentovaný překlad, vědecký styl, terminologie, syntax

Abstract

The task of the bachelor thesis is to translate a scientific text from the field of nuclear power plants and to analyze the language phenomena in the text. The work is divided into two major parts – practical part and theoretical part. Practical part deals with the translation of the scientific text. Theoretical part deals with the characteristics of the scientific style and with the language phenomena, namely the lexis and syntax.

Key words

commented translation, scientific style, terminology, syntax

ILLEK, P. *Komentovaný překlad*. Brno: Vysoké učení technické v Brně, Fakulta elektrotechniky a komunikačních technologií. Ústav jazyků, 2016. 36 s., 4 s. příloh. Bakalářská práce. Vedoucí práce: doc. PhDr. Milena Krhutová, Ph.D.

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V Brně dne 27.05. 2016 ....

(podpis autora)

I would like to thank my thesis supervisor doc. Krhutová for her inspiration and guidance during the writing period of my thesis.

Obsah

1 Introduction

English has a prime in majority of fields as a "lingua franca" and science is no exception. It is necessary to keep pace with the tide of new knowledge, and hence terminology, so we might be able to keep pace with the rest of the world. However understanding a scientific language can be tricky sometimes. To understand and translate a scientific paper one must have appropriate knowledge in the field of linguistics and science. This paper attempts to translate such text and provide an analysis of the present text.

The chosen topic of *nuclear power plants* may be well explored by the scientists however the distrust of wide public towards the technology gives space for, often heated, discussions whether the technology is safe. However, better understanding of the technology may lead to better acceptance among the people. Another reason why this topic was chosen is the familiarity of the topic with the author.

The paper is separated into two general parts – into the practical part where the translation itself is attempted and into the theoretical part.

In the theoretical part a brief introduction to linguistics is introduced followed by lexical analysis. The reader will learn about the differences between popular scientific style and scientific style. It is also mentioned that scientific style may also be divided furthermore into other subgenres as well. These subgenres are described and differences between them are stated.

The analytical part mentions the lack of loan words in the Czech language which is unusual in today Czech. Furthermore the reader learns about the density of terminology and its form in the translated excerpt. Following the lexical part is the syntax analysis where the reader learns about key properties of the sentences used to translate the original text. The differences between Czech and English

In the attachment a glossary of the used terminology, which was used for the analysis, can be found.

2 Translation

3.0 Nuclear power plants

Energy prediction of most countries, Czech Republic included, anticipate a rise in electric energy consumption. The highest rises in production of electric energy are expected in fast developing countries primarily in Asia, South America and North Africa. Population growth also plays a role in the matter. This inevitably rises a need for additional construction of energy sources especially power plants and central heating plants. However economically sustainable fossil supply is estimated to last in current times for decades up to hundreds of years. Respecting the future it is necessary to look for and develop new and more effective ways of producing thermal and electrical energy and to increase the efficiency of its transportation and consumption.

One of relatively new forms of usable energy which we were able to master in the past sixty years is the nuclear energy. This could probably shift imaginary border of depleting non-renewable resources into distant future after resolving technological problems with fast breeder reactors and especially after managing nuclear fusion.

In the last years nuclear energetics faces a form of crisis. Despite the fast post-war development, positive forecasts and euphoria of the sixties and seventies there has been a decline in its development since the second half of the eighties. First in the USA then in Europe. One of the main reasons is the public reaction to nuclear power plant accidents (Three Mile Island, Chernobyl and Fukushima) which are clear in the *fig. 3.1*[1]. Why is this the case when negative impacts on environment per one energy unit produced are substantially lower compared to most other sources of electric energy (according to independent comparative studies) and consequences of some ecological catastrophes are at least comparable (Bhopal, etc.)? Reasons are related to nuclear power plants specific status related to other sources of electricity and also with inhabitants' fear (and its frequent misuse) of the consequences of accidents. The consequent evasion of radioactive elements, treatment of the radioactive (spent) fuel and the unwanted waste created during fuel manufacture and distribution and the danger of

1 Figure is not included in the translation.

misuse of radioactive and fissionable products for military or terrorist purposes plays their role.

In developed countries there is a current trend in rising pressure on re-evaluating of energy situation and on decreasing financial sources for research and construction of nuclear facilities. On the other hand, there has been an significant increase in investment costs for construction of new power plants especially due to sophisticated conditions for licensing. Also the fact that there has been an optimal share of nuclear power plants in the electric power systems in some countries, limitations of export of nuclear technology into dangerous territories and lastly even lobbying of rival electric companies exploiting the situation played its role. Furthermore the decrease in financial resources impacted negatively the development of thermonuclear reactors – energy source of the next millennium.

Nuclear energetics will be widely accepted when its supporters show that positives outbalance negatives. At the same time its opponents must suggest viable, safer, feasible and economically sufficient alternatives of electrical energy which can satisfy future demand and which do not disproportionately burden households' economic costs. Common goal of both parties has to be the sustainable development on our planet.

Limited range of the book only allows to present basic information in the field of nuclear energetics. Relatively large part on elementary basis of physics is stated for easier understanding the matter of how nuclear power plant works and in this sense visual examples are presented.

Considering the fact that there are only pressurized water reactors installed in the Czech Republic and that in the future only such power plants are designed and because the majority of power plants in the world have this type of reactor (in use, being constructed or planned in the future) the following chapter is aimed primarily on this type of reactor namely the primary circuit.

3.1 Specifics of a nuclear power plant

Nuclear power plants use thermal energy generated during controlled nuclear fission. So far only controlled nuclear fission has been managed and used. Thermonuclear reaction safe managing (thermonuclear synthesis) which would practically solve problems related with energetics supply is currently being worked on in many research facilities. Unfortunately, so far the thermonuclear synthesis could be used (or rather misused) only in a spontaneous reaction – thermonuclear bomb.

Thermal energy is generated in nuclear power plants first and then it is converted into electric energy. Also, as opposed to classic thermal power plants where heat is generated from exotermic reaction by oxidation of (mostly) fossil fuels in nuclear power plants the process is different in many other major ways:

- "Fuel" for generating heat is in a specific period of time (fuel cycle) located in reactor in almost every nuclear power plant opposed to a continuous supply of fuel from the outside sources in a thermal power plant
- Concentration of energy for a unit of weight of a fuel is significantly higher in nuclear power plants. Thermal power plants are able to produce 1kWh of electrical energy from 1kg of brown coal whereas nuclear power plants with pressurized water reactors are able to generate 1GWh from 1kg of nuclear fuel which is about 10^6 times more. If we compare quantities of mined soil then the ratios are comparable because of a relatively low amount of uranium in ores. Nonetheless the numbers are again in favour of nuclear power plants – for one unit of energy it is necessary to extract ten to one hundred times more soil (including tailings) for thermal power plants than for nuclear power plants.
- Fission reactions generate radioactive isotopes with different half-life times. This is why the fuel or apparatus located near the fission reactions cannot be freely manipulated with for up to millions of years and must be secured against radiation leakage and against misuse.

- Nuclear reactors cannot be brought into immediate stop. The reason is the fission reaction in a reactor core which still generates heat after reactor shutdown and it needs to be transferred away safely in order to prevent coolant boiling and overheating fuel elements in the active zone to prevent any material damage followed by the radiation leakage. In case of pressurized water reactor the reactor generates more than 1% of originally generated heat after one minute from shutdown (for example the reactors in the Temelín power plant).
- Transferring residual heat after reactor shutdown can be usually done only by heat exchangers. That is the reason why there are several cooling circuits in nuclear power plants (circuits that transfer heat from the reactor towards turbines). By this safety measure the reliability of the process of heat transfer is greatly increased in case of any technological failure of a cooling circuit.
- During one fuel cycle the structure of the fuel changes – volume of fissile element decreases (fuel is "burning out"). This process needs to be compensated in time by amount of an absorber in the active zone with regard to the allowed amounts set by regulating and managing and safety authorities. Relatively large thermal gradients between fuel and coolant increasing the risk of damaging the fuel elements or their coverage and leakage by radioactive products from the fission process.
- Technically, technologically and financially demanding fuel cycle (the whole process during which the fuel is extracted in the beginning and stored/reprocessed when it burns out in the end).
- The absence of harmful elements CO_2, NO_X and SO_2 being released into the environment.

Description of a nuclear power plant

Generally every nuclear power plant can be divided into several sectors in regard of used technology, operating mode and security level into: area supporting reactor operation, machine room supporting turbines and for generating electrical energy, area technologically supporting the power plant. Reactor area and machine room are usually classified as one sector – the main block which is separated by wall into the reactor room and the machine room.

Technology supporting heat energy generation and its transmission into machine room is located in reactor room. The main components are: reactor, main circulation pipeline, main circulation pump, heat exchangers – steam generators, pressurizer (in pressurized water reactors), bubbler system, water tanks for reactor cooling, storage pools for spent and new fuel, systems for continuous coolant purifying, coolant refilling systems, regulating and safety systems, measurement and control systems, etc. Devices located inside the active zone including reactor coolant with operating parameters (pressure and temperature) are inside so-called containment in newer power plants. Containment is a safety vessel minimizing potential damage in case of an accident. Its main purpose is to ensure safety of the primary circuit so no harmful elements may escape or interfere with said circuit. Containment creates hermetically sealed space. Its strength is designed to withstand overpressure during coolant leakage in case of maximum projected accident (rupture of the main circulation circuit). At the time of normal functioning there is always a slight subatmospheric pressure to prevent leakage of radioactive isotopes into the atmosphere. Today some currently being built power plants have two containments. One made of steel – inner one – to ensure airtightness and to enable cooling from the outside and the second made of prestressed concrete.

In reactor room each technology in it must be organised in a fashion to cover the least amount of space possible in order to minimize hydraulic losses and losses caused by heat transfer with low parameters as well as to minimize construction costs (containment is structurally complicated and therefore financially demanding component). Nuclear reactor is usually situated in vertical position and symmetrically surrounded by biological shielding, heat exchangers and circulation pumps. Above the cover of the reactor (in case of pressurized water reactors underneath) is an empty space guaranteeing safe fuel and built-in components exchange and also access to regulation and safety systems. Heat exchangers, circulation pumps and connecting pipelines are placed in flexible or movable bed in order to minimize mechanical stress caused by temperature dilatations. From the space efficiency perspective it is better to place heat exchangers vertically but in case of VVER reactors the steam generators are placed vertically. Steam generators in case of reactors with water coolant should be placed in such height that entire cooling circuit remains flooded after the reactor lid has been lifted.

There are more strict rules for reactor area than in the rest of the power plant. Only limited amount of employees have access to the area. The area is divided into several zones usually hermetically separated with different levels of allowed access up to total restriction of access when the reactor is running.

Machine room is basically not different from the ones in thermal power plants although turbines work under greater powers and with steam of lower parameters. In case of pressurized water reactors and boiling water reactors the steam is saturated. Regarding the fact the dimensions of turbines, separators, pipes and fittings are bigger. Also there is a requirement for the shortest distance possible between the exchanger and the turbine.

In most cases and the block layout is used which means that for one reactor there is one turbine with no particular requirement for orientation of the axis of the turbine. The exception are, for instance, blocks with VVER 440 reactors (e.g. in Dukovany) with two vertically oriented turbines with power of 220 MW.

In nuclear power plants even the machine room must be secured against potential leakage of radioactive steam particles and the condensate. These can get into the secondary circuit through a leak in the heat exchangers (steam generators) between the primary circuit and the secondary circuit. Therefore higher standards are required for device sealing in the machine room and for returning steam leakage back into the piping. If radioactive gases are present (H3, O19, N16, N17) in the secondary circuit then they are separated by an ejector. Afterwards they pass through a bin which serves as delay mechanism ensuring a decrease in radioactivity of the gas. Finally the product is filtered before releasing the gas into the atmosphere.

Auxiliary machine room – space between the reactor room and the machine room. Technologies supporting the secondary circuit of steam generators are installed here!!! (E.g. turbo generator, condensers, powerheads, power collector and steam collector). Auxiliary generators are also counted among important equipment that is installed here. They are used during powering up or down the power plant and during the "hot reserve" (a state in which the power plant is ready to be connected to the power grid and the electricity generation covers just the needs of the power plant) and the oil management**.** Usually the control room is located in the auxiliary machine room.

Auxiliary systems. In nuclear power plants there are several systems which are not part of the main technological process. Nonetheless without them the nuclear power plant would not be able to function. In the secondary circuit part of the power plant the auxiliary systems have similar functions as they have in the thermal power plants. Despite the fact that in nuclear power plants their reliability has to be much higher. In the primary part there are many auxiliary systems with special mode because radioactive materials are used there.

The most important auxiliary systems of the primary part are: fuel containment storages; systems for water cleaning and water adjustments for the primary circuit and for the fuel exchange pool; special sewerage systems and wastewater treatment systems for the sewage from various filters, blowdowns, leaks, laundry rooms etc.; storage and thickening of the active liquid waste; storage of the solid active waste; decontamination solutions preparation room; special control laboratories; technical gas bins etc. Auxiliary systems of the primary part are located in a separate building and they usually serve more than one block.

One of the most important systems from the safety perspective are redundant diesel generators. Their task is to supply electric energy in case of a failure of both - the main and the standby power sources for own needs of the power plant. They generate electric energy needed to shut down the reactor safely (i.e. to safely transfer away residual heat and to keep safety systems active).

Nuclear power plant and its surroundings are divided into several zones. According to allowed radioactivity levels there are: controlled zone, clear zone, hygienic zone and zone for observation and protection of nearby surroundings. For example the whole primary circuit belongs into the controlled zone.

Circuits in nuclear power plants

Heat generated during fission of the nuclear fuel is transferred by an enclosed circuit through a coolant which can be water, gas or liquid metal (Na). In case of power plants with only one circuit heat is transferred directly into the turbine. But in most cases the power plant has two circuits which means that the heat goes through a heat exchanger. Heat exchangers are also called steam generators. Steam generator generates steam with required parameters which drives a turbine (the same way as in thermal power plant) mechanically connected to an alternator. Nuclear power plants, where liquid metal (sodium) is used as a coolant, have one additional circuit – an intermediate circuit. In this circuit liquid metal is also used as a coolant but it flows under higher pressure than in the primary circuit in order to prevent any radioactive leaks into the secondary circuit. These power plants are often called "three circuit power plants". Flow of the coolant between the source (reactor) and the heat consumption (turbine, exchanger) is called primary circuit.

Flow of the heat transfer medium (steam) between the steam generator and the turbine is called secondary circuit.

Elementary types of nuclear reactors

There are several vital parts in every reactor: nuclear fuel, moderator, substance for heat transfer – coolant, airtight system, shielding, reflector, breeder zone, control and safety systems, measurement and diagnostic systems.

Mainly by combining the first three components and different energetic spectrums of fissionable neutrons we can create many types of nuclear reactors. Basically every component can have a different form. Importance of some components can be reduced (moderators in fast reactors) or in some cases replaced (a moderator can be the coolant as well; reflector can be part of the control system etc.). And for these reasons there are many possible combinations and therefore many different concepts of the reactor. Not every concept is appropriate however. After more than half a century of nuclear reactor constructions few concepts have proved themselves to be adequate. The types of nuclear reactors being built and designed nowadays are improved versions of such concepts, with higher reliability and security, including orientation on passive and inherent principles.

Division into categories can be done from multiple viewpoints. In the beginnings of nuclear energetics there were two elementary groups defined by fuel and moderator arrangement:

Homogenous reactors – the fuel is diffused inside the moderator. It has the form of a solution, chemical compound, alloy or a suspension of powder fuel in a liquid. The main advantage is the ability of the continuous exchange of the fuel during the reactor uptime.

Heterogeneous reactors – the fuel is separated from the moderator. The fuel is kept inside a hermetically enclosed fuel element so that no radioactive substances might leak into the coolant or into the moderator. In case of heterogeneous reactors the coolant is usually also the moderator.

Heterogeneous reactors are used primarily in the field of energetics because the technological part is better managed. There are few "demonstrative" and experimental "very-high-temperature" reactors in use which could be called (quasi)homogeneous. The fuel has a form of pellets made of enriched UO_2 and graphite. The fuel is continuously poured into the reactor from the top and the spent fuel is removed from the bottom of the reactor. Graphite is both the moderator and the barrier ensuring that no fission elements escape to the environment. Homogeneous reactors will, probably, find their use in the near future as "subcritical" systems when disposal (or transmutation) of highly radioactive materials is needed. In such a system the nuclear fuel with highly radioactive wastes have the function of a coolant, contained in molten salts.

From the physical perspective we recognize thermal reactors and fast reactors (i.e. divided by the energy of the neutrons in time of the nuclear fission).

Thermal reactors – the nuclear fuel fission is mostly caused by thermal neutrons – neutrons which have energy lower than 1eV. These types of reactors must have a moderator which slows down newly generated neutrons by 6 to 7 orders of magnitude.

Fast reactors – reactors essentially without a moderator. The fission reaction is caused by neutrons which have energy larger than 0,1MeV. Due to the fact that during the fission reaction new fissile material is created (in most reactors) the fast reactors can be called breeder reactors.

Between the range of thermal reactors and fast reactors, from the neutron energy perspective, there are also epithermal and intermediate reactors. The fission reaction in the epithermal reactor is caused by neutrons with energies greater than 1eV; however they do not exceed the energy level by much. In the intermediate reactors neutrons mostly have energies in the middle spectrum, i.e. the energies which neutrons have are between tens of eV up to tens of keV. Both described types of reactors have not found wider use in the energetics field.

Furthermore we can divide reactors into groups by use:

Power reactors – they generate thermal energy for immediate distribution and consumption (nuclear heating plants). Or the generated energy is converted into another type of energy such as electric energy (nuclear power plants) and mechanical energy (nuclear actuators and propulsion).

Research reactors – they vary in neutron flow (output power). Their main purpose is the research in the field of nuclear physics, namely research of radiation and the influence of radiation on materials and live organisms.

Experimental reactors – their main purpose is to gain physical data in order to develop new types of reactors and to better understand their behaviour during operation and accidents. Special cases are so-called prototype reactors and demonstration reactors which have the same properties but much lower parameters than the future manufactured reactors.

Industrial reactors – they are used, for example, in chemical industry in order to induce radiochemical changes in large quantities (e.g.: to make hydrogen, to produce drinking water, in preservation, in pharmacology, in agriculture (seeds), in preservation and restoration of antiquities, etc.).

Production reactors – their purpose is to create various isotopes, emitters and to create secondary fuel (so-called breeders).

Educational reactors – they have low to very low output (so-called zero output). Along with the high level of security we can safely create even dangerous scenarios without any risk. Together with trainers they are used in training of the future crews of the reactor. They are also used to check knowledge of crews in time, creating specific scenarios etc.

Power reactors

Power reactors are most commonly divided into groups by their type of coolant and what type of moderator they are using. If the physical concept or its parameters differentiate from usual types of reactors then the specific property is also stated in the name of the reactor (fast, advanced, high-temperature, etc.). Type of the fuel is usually not stated in the name given that exclusively uranium is used so far (differentiating only in the level of enrichment and its form). Table showing the most frequent types of power reactors along with the percentages is shown in the *fig. 3.11*[1].

By the end of the year 2011 there were 434 nuclear power reactors in use with total installed power of 368 GW. Sixty-four more reactors were built at the time with combined installed power of 62 GW (data take from PRIS on 5.12.2011). The types of reactors in use are unevenly represented due to economical, technological and safety reasons. The picture shows representation of the most used reactors considering their installed power. The portions are most likely to change in the future in favour of the safe pressurized water reactors (83% of newly developed reactors).

Forms of nuclear fuel

The most commonly used nuclear fuels are: natural uranium enriched with uranium 235 (1,5 – 5 %); natural uranium (with the isotope composition of: 99,276 % U238, 0,718 % U235 and approx. 0,004% U234); MOX fuel (mixed oxide fuel) made from depleted uranium from the enrichment facilities and plutonium, which comes from "spent" nuclear fuel or from discarded nuclear warheads. The MOX fuel does not need to undergo the energetically demanding enrichment process. In the mix there are 7 % Pu (in case of military plutonium only 5 %) and Th 232 which is changed into U233 after a collision with a neutron followed by β^- decay which is easily fissile.

1 Figure is not included in the translation.

Uranium-metal fuel – was used mainly at the beginning of the era of nuclear energy. The moderator can be graphite or heavy water. Its advantages are good thermal conductivity, higher concentration of fissile atoms and easier reprocessing of the spent fuel. However it melts at the temperature of 1133 °C and it has relatively small chemical resistance. The uranium is therefore not used in its pure metallic form nowadays because of these disadvantages. Although, if use of the metallic form is expedient, its chemical and thermal parameters can be improved by various additives (Cr, Ni, Zr, Mo, Al).

Ceramic fuel cells – the most used chemical composite is UO_2. This type of fuel has many advantages such as: high melting point (2878 °C), it does not react with other materials, it does not have phase transitions. The disadvantages of this type are:

lower thermal conductivity and lower amount of fissile nuclear cores (and thus the necessity for higher levels of enrichment). The fabrication of a fuel cell has several stages: first the powder form is pressed together to form a pellet and then it is precisely machined. Afterwards the product is placed into a tube coating followed by vacuum drying. The whole process is finished when the tube is filled with a protective gas and hermetically sealed (canned).

The pellet itself is the first safety barrier. Almost all radioactive elements stay inside the pellet (99 %) if the pellet is not damaged (melted).

Fuel elements

The fuel itself, sealed in a protective container preventing leakage of the fission products and the protective components (e.g. filling gas), is called the fuel element. Depending on its shape the fuel element is also called rod, fuel rod, pellet. The fuel element is therefore basic, hermetically sealed, structural element of the nuclear fuel assembly. Safe functioning of the reactor is dependant on the quality of the fuel elements and their coverage. Tightness failure of the fuel element cover means failure of the second safety barrier. This means higher probability of contamination of the coolant by the fission products.

Coverage failures are eliminated by high quality of the coverage material, by perfect vacuum drying before sealing, by optimal pressure of the filling gas (in the container) and by avoiding abrupt changes of the reactor power output. The container materials have to meet these requirements:

- Low absorption rate of neutrons, low secondary reactivity, stability of the material
- High coefficient of thermal conductivity, low coefficient of thermal expansion – or rather small differences between the coefficients of thermal expansion between the fuel and the tube container
- Excellent hermetical properties
- High mechanical strength even at high temperatures
- Great resistance to corrosion and erosion caused by the fuel and the coolant
- Good ductility and weldability
- Cost efficiency

3 English in the world of science – Introduction

Concurrent scientific papers are published mostly in English (up to 95% of them according to some websites). But it has not always been the case.

Simply put: until the 19^{th} century the main language of science had been Latin (in Europe) - I am not including any other languages such as Arabic or Chinese. They may have been significant languages of science in the past but they did not play a role in forming of the current state in which the "language of science" is in now. Anyway at the start of the 19^{th} century popularity of Latin was on a decline and there were three other major languages on the field – French, English and German. In fact German language was the most popular of the three and nothing suggested total domination of English in the next century. Up until the First World War. After the Great War scientists from Germany and Austria were boycotted in the western world as well as German language. With economic and scientific rise of the USA the fate of English in becoming a "lingua franca" in the scientific world was sealed.

However this topic may be interesting it is not the aim of my work nonetheless the brief summary provides context on why English is the main language in the scientific world which I believe was necessary.

Further on I will distinguish popular scientific texts and "purely" scientific texts and based on my notes I will classify my translated text. Moreover my task is to describe basic translation processes and provide examples from said text and finally I shall compare syntax of both languages – Czech and English in order to describe the differences between the languages and to show different approaches for translation.

4 Scientific style and popular scientific style

Style used in scientific texts is quite unique. It differs from any other written genre by including specific expressions - terminology and excluding a possibility of any other interpretation than that was originally intended. Its main task is to inform the reader "the most precisely, most accurately and entirely" (Knittlová, 149).

Gaĺperin suggests that it is important to distinguish between *humanitarian science* and *exact science*. It is argued that humanitarian sciences use much more complicated, inaccurate terminology and due to the lack of concrete data from research the authors must necessarily resolve for more open texts, i.e., scientists from the field can not often write any definitive articles or statements for there is usually the lack of evidence. Therefore they usually have to use what I would call "soft scientific style". It means that they use language which is "close to journalistic style" (Knittlová, 150)

On the other hand exact sciences have plenty of data and therefore exact statements can be written (although hedging is still present in case the data were misinterpreted). Because of the fact there is minimum possibility of misinterpretation of the written text (in fact there should not be any) when using terminology a lot of unnecessary information can be omitted. Therefore common/colloquial expressions which one would find e.g. in a story book are not present in these texts. Also we can not forget that when one writes a scientific text he (or she) depends strongly on the same level of knowledge of the recipients ensuring that the writer can be implicit. Being implicit is useful simply because there would not be enough space if the author tried to explain everything. For this reason these texts are designated only for a certain group of people – the experts.

The opposite of that are popular scientific texts which aim to attract as many readers as possible. Again the style is close to journalistic style. This time it is because the texts are most often published as articles in magazines or on websites. Of course there are plenty of scientific books too but if we compare style used in books and articles it does not differ from each other much. When writing such text the author considers the recipients do not have any knowledge in the field and when explaining science he uses colloquial terms and expressions such as "thin as paper, essentially, figure out" [1]. Also the writer tries to set himself on the same level as the recipient by using inclusive expressions such as "if we look at; our component". This sets a friendly tone in the text which, again, ensures better accessibility for wider audience.

Now my translated excerpt can be easily categorized as a scientific text for the style is simplistic, without any unnecessary expressions and with the level of impersonalization we can find in such texts. Colloquial expressions are present but they are not as frequent as they would be in popular scientific text.

5 Analysis

Linguistics offers a wide variety of disciplines and therefore a wide variety of options for how to analyse a text (and a translated one). However not all of them are relevant when discussing translation of a scientific text. Translator should have in mind that in this case the most important thing is the meaning. The message that crosses the language barrier must not be altered because otherwise the consequences of misunderstanding/mistranslating could be dire.

From my point of view two categories are particularly worth investigating – lexis and syntax. Syntax because English is an analytical language and Czech is a synthetic language (although not completely but generally can be categorized as such) hence differences in grammar can be identified easily. Lexis is interesting for the same reason, plus the necessity to translate it precisely in scientific texts. The special role of lexis in scientific texts inspired me to investigate it further on following pages.

1 The example was taken from the popular scientific article at http://electronics.howstuffworks.com/everyday-tech/blood-battery.htm .

5.1 Lexical analysis

5.1.1. Loan words in Czech language

Nuclear energy and technology needed for it, and terminology tied to it, were researched in the past century – from the fifties to the eighties (of course the research is still undergoing but only translated excerpt is taken into consideration). The terms essential to cover the topic were "born" into a torn world. The world was divided into "west" and "east". Therefore I suppose that if we were part of the eastern world then the terminology was also affected.

My assumption is that there was a pressure to adapt Russian expressions instead of English ones or to create a new Czech term and therefore there is less English terminology in the original excerpt, than there is in contemporary Czech scientific texts. The assumption is based on my experience during translation when the author had to look up and look for words completely differentiating from the Czech ones (e.g. *bubbler system – barbotážní systém*). If the translated text was about information technology the experience would be much smoother because many expressions are directly taken from English (e.g. *software*, *server*).

Moreover if we compare the technologies that were around during those times and the technologies that exist nowadays it must be stated that in the past the world was a lot "slower". Because of the internet inexistence the information spread much slower compared to 21st century and therefore the language had more time to adapt (unlike in current times).

It should also be mentioned that not all technology had to be invented – portion of it already existed e.g. steam turbines, and therefore the likelihood of loan words decreased furthermore. These factors, in my opinion are the reason that there are few to none loan words in the translated text which greatly differs from concurrent scientific papers.

5.1.2.Density of terminology and its form

One of the most characteristic phenomenon of the scientific texts is the recurrence of expressions/terminology. It is typical for the style for it helps to eliminate any ambiguity and enables better communication of an idea. Therefore the texts tend to be dense with expressions and rather stereotypical (Knittlová, p 149). What is usually not being said is how dense the terminology tends to be, whether it is ten terms per one hundred words or forty terms per one hundred words. The translated excerpt was analyzed from this perspective with these criteria in mind:

- The terminology counted is the terminology referring to the topic of the scientific text i.e. nuclear power plants; and therefore some expressions were omitted (for the full list of the terminology included in the investigation see the attachment).
- Statistically the terminology consists mostly of compounds with two words hence one expression is counted as two words.
- Any duplicates or recurring expressions are also counted.

The count revealed that there are 343 technical expressions and therefore about 686 technical words in the first 2 870 words which means that approximately every 4th word is part of a technical term. The count also revealed the most used expressions. These are the top five (or rather six):

Terminology	number of times mentioned in the text
reactor/nuclear reactor	24
nuclear power plant	20
power plant; fuel/fuel element	17
coolant/reactor coolant	13
turbine	11

1.0 Table showing the most frequent expressions. Compounds and single words referring to the same thing were counted together.

From the perspective of terminology density the results may be a little surprising at the first sight until it is put into a perspective. It basically means that in every sentence there is just one or two technical terms (with the exception of the enumerations) due to the fact that compounds are the majority of the terms used. On the other hand totally unsurprising is the count of the most used terminology where the most used word/compound is reactor/nuclear reactor (they both refer to the same thing and therefore were counted as one expression) when we consider that the text deals with nuclear power plants.

As was mentioned earlier the majority of the expressions were compounds of two words. It is in the nature of English that one word is more general term and the second one specifies it. Furthermore it is argued that most of the terminology are nouns. Therefore the excerpt was analysed from this point of view to decide whether these conditions apply to it. These were the rules considered during the analysis:

- The terminology investigated is the terminology referring to the topic of the scientific text i.e. nuclear power plants; and therefore some expressions were omitted (for the full list of the terminology see the attachment). (the same as the previous investigation)
- In order to avoid duplicates (this time they are not desirable) the expressions with similar wording must have different meanings i.e. referring to different things, otherwise they will be counted only ONCE (e.g. *fission reaction* = *nuclear fission*).
- If both colloquial term and an independent term appears in the text only the independent term is considered – provided that they both refer to the same thing (e.g. nuclear reactor – *reactor*).

•

	number of terms	percentage
N	27	20%
V	4	3%
A+N	40	30%
N+N	39	29%
A+A	1	1%
A+N+N	9	7%
N+N+N	10	7%
N+A+N	2	1%
A+N+N+N	2	1%
N+A+N+A	1	1%
total	135	100%

1.1 Table showing the word class distribution of the terminology used in the excerpt.
A = adverb; V = verb; N = noun; percentages are rounded accordingly

The table shows that only about 3% of all the terminology were verbs (*shut down*) which was expected. Although if we look at the excerpt, there can be found more verbs that are related to the terminology of nuclear power plants. It can be argued that these should have been added as well, however these verbs have rather "colloquial nature" (*goes, transfer, work*) and therefore they lack the "uniqueness" that the rest of the terminology have and hence were left out.

The table also shows that there are less independent nouns (*alternator*) – 20% than there are compounds (*radioactive element*) – 77%. The results are affected by the specifity of the topic and by the nature of English (as it was mentioned earlier). The need to describe certain phenomena and specify tasks of various machinery drove the language into using more compounds.

From the table it is clear that from compounds the majority were combination of an adjective and a noun (*primary circuit*) and a noun and a noun (*research facility*). Only a small amount (compared to the rest of the compounds) were compounds with three or more words such as combination of three nouns (*pressurized water reactor*), combination of an adjective and two nouns (*controlled nuclear fission*) or combination of an adjective and three nouns (*decontamination solutions preparation room*).

It was proven that the text has terminology consisting mostly of nouns or nouns specified by other nouns or adjectives which shows that the excerpt is typical scientific text for "the scientific style is term-oriented; nouns and eventually adjectives are the typical parts of speech." (Knittlová 2010: 149)

6 Syntax analysis

As mentioned earlier the English language is an analytical language and Czech is a synthetic language. Hence the difference in syntax may cause trouble in translation especially when one translates a scientific text. If we compare rules for the word order in the sentences in the two languages then English has comparably stricter rules which are followed in every sentence unlike in Czech where its rules are more relaxed and the language tends to have larger number of complex sentences:

Fast reactors *- reactors essentially without a moderator. The fission reaction is caused by neutrons which have energy larger than 0,1MeV.*

Rychlé reaktory *– jsou to reaktory v podstatě bez moderátoru, které využívají ke štěpení především rychlé neutrony, tj. Neutrony s energií nad 0,1 MeV.*

Czech can express rather complex ideas in one sentence and it makes sense for the recipient but if we wanted to convey the same information in a single sentence in English as well, the main idea could be lost, therefore it is better in some cases to divide one sentence into two sentences. Although long sentences in English, specifically in scientific language, are quite common the different rules for arrangement of words do not allow conveying the ideas the same way. The Czech language has arguably more options when it comes to sentence structures and therefore the English translation has to adjust accordingly – dividing the sentence ensures elimination of ambiguity.

Also in some cases it is necessary to add information to the sentence and in other cases it is better to omit redundant information. Such situations can also be caused by difference in lexis where in one language the information is expressed by one word but in the other language we need to express the same information with a collocation or a sentence:

Their task is to supply electric energy in case of a failure of both - the main and the standby power sources for own needs of the power plant. They generate electric energy needed to shut down the reactor safely.

Tyto mají za úkol v případě ztráty hlavního i rezervního napájení vlastní spotřeby elektrárny elektrickou energií toto napájení nahradit v takovém rozsahu, aby bylo možné reaktor bezpečně odstavit.

Here we can see that the message is slightly altered – the Czech meaning *"<u>nahradit v takovém rozsahu</u>, aby bylo možné reaktor bezpečně odstavit.* is contained in the English sentence *"They generate electric energy <u>needed</u> to shut down the reactor safely"* where it is clear that the amount of energy generated covers the needed amount of electricity. In this example the Czech "*rozsah*" and "*nahradit*" are not translated explicitly into the English for they are arbitrary information (as stated above). By omitting this direct translation the sentence could be divided into two which conveys the message clearly – although division is not necessary it allows better understanding of the issue.

As have been already mentioned at the beginning - the message must always be the same unlike, for instance, when we consider novels where the situation is more relaxed when the translator can adjust the meaning to better suit the target language audience for example (to adjust for differences in cultures). But unlike in novels technical texts do not have to deal with such situations, for they mostly evaluate data and the process does not need and should not need such content (although debatable situations still appear as shown above). But how do we know a sentence belongs to the scientific genre?

The first thing that a reader notices is the lack of personality in scientific texts. It is given by the fact that the author states a fact, something well known and documented. The same level of impersonality is also present in Czech texts:

The fuel element is therefore basic, hermetically sealed, structural element of the nuclear fuel assembly.

Palivový element je tedy základní, hermeticky uzavřený, palivový stavební prvek, ze kterých se skládá palivový soubor.

The impersonality is achieved by using passives such as: ... *it is precisely machined*; *The fuel has a form* ... etc.

Furthermore the impersonality has rather objective form. It is much more credible to say *"It was found out..."* than *"I found out..."* because in the first case the statement is supported by a set of data (however implicitly). It is the aim of scientists to sound credible, to refer to concrete set of data, in order to be accepted by their colleagues so it is natural for the style to contain high number of passive forms. In the world of exact sciences (especially) it is desirable to be as much objective as possible and it is thus unsurprising to find that: *"according to Dušková there are about 20% passive forms used in scientific texts, however in a spoken dialog there are just about 3%"* (Knittlová: 152).

Subjectivity in scientific texts, especially in exact sciences, is not common although it still can be used. When one uses subjective form such as *"I conclude..."* rather than the objective form *"It was concluded..."* then he or she refers to personal standpoints or their own findings. However scientists in technical disciplines usually work in teams and therefore usage of the form is rather unusual although acceptable.

In case of popular scientific style the objective forms such as *"If we look..."* is quite usual. Usage of objectivity attracts attention of the recipient and encourages him to read about the addressed issue no matter how uninstructed in the field he may be.

However in technical papers the structure of the sentence, besides the impersonality level, has certain patterns. A. J. Herbert in his book *The structure of technical English* argues that the basic pattern of such texts is

IT IS + ADJECTIVE + TO + INFINITIVE

Therefore it is slightly peculiar that in my work this exact structure appears only about eight times. The reason for this could be that the English text in this work is translated from Czech and thus the language is affected by the fact. Furthermore a native speaker might choose this particular pattern more frequently.

This particular pattern is comparable to its Czech counterpart:

Na jednotku vyrobené energie <u>*je třeba u tepelných elektráren vytěžit*</u> *řádově 10 až 100krát více horniny (včetně hlušiny) než pro jaderné.*

... for one unit of energy <u>*it is necessary to extract*</u> *ten to one hundred times more soil (including tailings) for thermal power plants than for nuclear power plants.*

Vzhledem k budoucnosti <u>*je proto nutné hledat a rozvíjet*</u> *nové zdroje a efektivnější způsoby výroby tepelné a elektrické energie a zvyšovat účinnost jejího transport a spotřeby.*

Respecting the future <u>*it is necessary to look for and develop*</u> *new and more effective ways of producing thermal and electrical energy and to increase the efficiency of its transportation and consumption.*

In these two particular examples we can see that the pattern stated above generally can be applied even to the Czech text. However differences can be clearly observed – the translation in the second example mirrors the original text whereas the first example has changed word order. That is given by the different *theme* and *rheme* placement in both languages. Generally in Czech the structure of a sentence in scientific environment the theme comes first and then comes the rheme whereas in English this is not always possible due to its strict word order the signalization of rheme has different rules – although the scientific texts follow the same patterns in both languages (impersonality, objectivity, formality, ...) and therefore the texts tend to mirror each other in most cases.

7 Conclusion

The first task of selecting appropriate text for translation was done by the author. The decision was made based on several factors, mainly for the suitability of the text being written in typical scientific style and for the familiarity of the field the excerpt describes.

The work was divided into two major parts – the translation (practical part) of the scientific text and the theoretical part including the analysis of the text.

The translated excerpt was taken from the book called *Jaderné a klasické elektrárny* by variety of authors (see list of references). The translated text is an introduction to the part dealing with nuclear power plants.

The theoretical part briefly describes why English is the most used language in the scientific texts. Also properties of scientific texts are briefly described first before the text deals with the analysis itself. First the lack of loan words compared with contemporary trend is mentioned. In the further analysis it was found out that statistically every fourth word of the text is a scientific term or a part of one. Also it is mentioned which expressions are mentioned the most. Further analysis showed that the majority of terminology was created by compounds consisting mainly of nouns.

It was concluded that the text shows every aspect of the scientific text - the density of terminology and its form meets the definitions of scientific texts.

The second part of the analytical part deals with syntax structure and its differences in both languages. Different approaches to translation are mentioned and shown however they only "scratch the surface" of the problematic since there are many approaches and differences in the languages which could not be mentioned due to length limitations.

Further investigations could show patterns in translations since the language of science uses the same properties (as stated in the work) in both Czech and English. Which I believe, could provide for an automatic translator programme because there is no need for culture adjustments and the language itself is simple to follow – the languages show a lot of similarities in scientific texts.

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Attachments

Translated expressions/glossary of words used for lexical analysis:

English expression	Czech expression
energy	energie
electric energy	elektrická energie
energy source	zdroj energie
power plant	elektrárna
nuclear power plant	jaderná elektrárna
fossil fuel	fosilní palivo
thermal energy	tepelná energie
nuclear energy	jaderná energie
non-renewable resources	neobnovitelné zdroje
breeder reactor	množivý reaktor
nuclear fusion	jaderná fůze
nuclear energetics	jaderná energetika
environment	prostředí
energy unit	jednotka energie
ecological catastrophe	ekologická katastrofa
electricity	elektřina
radioactive element	radioaktivní element
radioactive fuel	radioaktivní palivo
fuel	palivo
radioactive product	radioaktivní produkt
fissionable product	štěpný produkt
energy situation	energetická situace
nuclear facility	jaderné zařízení
nuclear technology	jaderná technologie
thermonuclear reactor	termojaderný reaktor
pressurized water reactor	tlakovodní reaktor
reactor	reaktor
primary circuit	primární okruh
nuclear fission	jaderné štěpení
controlled nuclear fission	kontrolované jaderné štěpení
thermonuclear reaction	termojaderná reakce
thermonuclear synthesis	termojaderná syntéza
energetics supply	energetická zásoba
research facility	výzkumné zařízení
spontaneous reaction	spontánní reakce
thermal power plant	tepelná elektrárna
exothermic reaction	exotermická reakce
oxidation	oxidace
fuel cycle	kampaň (palivový cyklus)

brown coal	hnědé uhlí
nuclear fuel	jaderné palivo
uranium	uran
radioactive isotope	radioaktivní izotop
half-life	poločas rozpadu
radiation	radiace
reactor core	jádro reaktoru
coolant	chladivo
heat exchanger	výměník tepla
cooling circuit	chladící okruh
turbine	turbína
burn out	vyhořet
absorber	absorbátor
active zone	aktivní zóna
fuel rod	palivový článek
fissile element	štěpný element
reactor operation support	zajištění provozu reaktoru
machine room	strojovna
reactor room	reaktorovna
main circulation pipeline	hlavní cirkulační potrubí
main circulation pump	hlavní cirkulační čerpadlo
steam generator	parogenerátor
pressurizer	kompenzátor objemu
bubbler system	barbotážní systém
storage pool	skladový bazén
coolant refilling system	systém pro doplňování chladiva
continuous coolant purifying systems	systém pro kontinuální čištění paliva
regulating system	regulační systém
safety system	bezpečnostní systém
measurement system	měřící systém
control system	kontrolní systém
containment	kontejnment
hermetically sealed space	hermeticky uzavřený prostor
overpressure	přetlak
prestressed concrete	přepjatý beton
biological shielding	biologické stínění
reactor cover	víko reaktoru
flexible bed	flexibilní podloží
water coolant	vodní chladivo
reactor area	reaktorová část
hydraulic losses	hydraulické ztráty
heat transfer	přenos tepla
boiling water reactor	varný reaktor
saturated steam	sytá pára
separator	separátor

steam particles	částice páry
condensate	kondenzát
secondary circuit	sekundární okruh
steam leakage	únik páry
radioactive gas	radioaktivní plyn
ejector	ejektor
bin	zásobník
auxiliary machine room	mezistrojovna
turbo generator	turbonapáječka
condenser	kondenzátor
powerhead	napájecí hlava
power collector	napájecí kolektor
steam collector	parní kolektor
auxiliary generator	pomocná napáječka
power up	najíždění (elektrárny)
power down	odstavení (elektrárny)
hot reserve	horká rezerva
power grid	elektrizační soustava
oil management	olejové hospodářství
control room	velín
auxiliary systems	pomocné provozy
fuel containment storage	sklady kontejnmentů s palivem
water cleaning systems	systémy pro čištění vody
water adjustment systems	systémy pro úpravu vody
fuel exchange pool	bazén pro výměnu paliva
special sewerage systems	systémy speciální kanalizace
wastewater treatment systems	čištění odpadních vod
blowdown	odluh
active liquid waste	aktivní tekutý odpad
active solid waste	aktivní pevný odpad
decontamination solutions preparation room	přípravna dezaktivačních roztoků
technical gas bins	zásobníky technických plynů
redundant diesel generator	redundantní dieselgenerátor
main power source	hlavní napájení
standby power source	záložní napájení
shut down	odstavení (reaktoru)
alternator	alternátor
intermediate circuit	vložený okruh
radioactive leak	radioaktivní únik
transfer medium	přenosové médium
moderator	moderátor
shielding	stínění
airtight system	vzduchotěsný systém
reflector	reflektor
breeder zone	množivá zóna

diagnostic system	systém diagnostiky
energetic spectrum	energetické spektrum
fissionable neutrons	štěpné neutrony
fast reactor	rychlý reaktor
homogenous reactor	homogenní reaktor
heterogeneous reactor	heterogenní reaktor
spent fuel	vyhořelé palivo

Original text

For the original text please see enclosed CD.